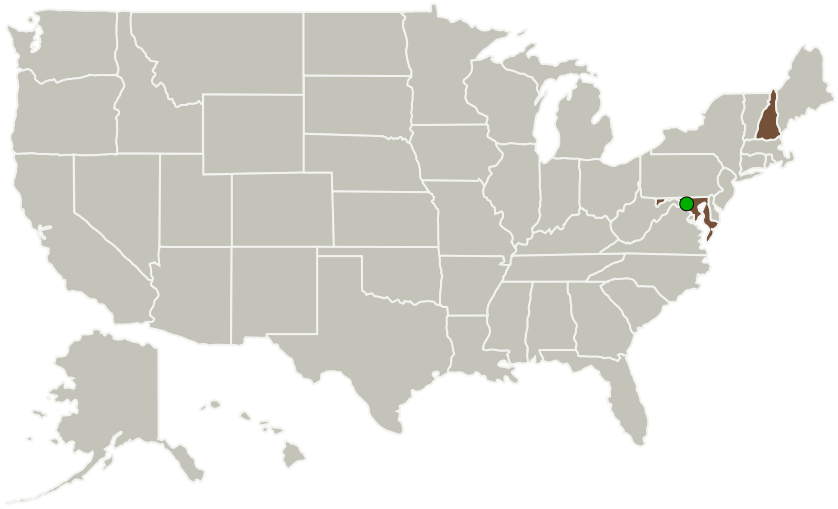
# An Ultra Low Power Cryo-Refrigerator for Space, Phase II

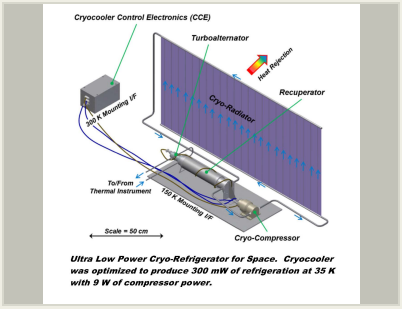
Completed Technology Project (2012 - 2014)

## Project Introduction

Future NASA Space Science Missions will incorporate detectors, sensors, shields, and telescopes that must be cooled to cryogenic temperatures. An enabling technology for these missions is advanced cryocoolers that can provide continuous and distributed cooling with minimal input power. On this program, Creare proposes to develop and demonstrate an innovative cryocooler that produces refrigeration at temperatures of 30 to 70 K and rejects heat at a temperature of 150 to 210 K with extremely high efficiency. The heat rejected can be absorbed by an upper stage cryocooler or rejected to space through a small cryo-radiator. The overall mass of the cryocooler, cryo-radiator and electronics is nominally 6 kg, the area of the cryo-radiator is 0.8 m2 and the input power is significantly less than current state-of-the-art cryocoolers. The electronics utilize parts that are tolerant to 300 kRad total ionizing dose. In addition, the cryocooler technology is extremely reliable and scalable, and produces no perceptible vibration. The key innovation is a cryogenic compressor which has heritage to the cryogenic circulator developed by Creare and operated on the Hubble Space Telescope for 6.5 years. On the Phase I project, we optimized the cryocooler design for a particular mission class and predicted the performance of the cryocooler using a combination of analyses and component-level test data. On the Phase II project, we will build and test a demonstration cryocooler and cryo-radiator. The Phase II testing will be structured to achieve a TRL of at least 5, and will include cryogenic performance and launch vibration testing.

## Primary U.S. Work Locations and Key Partners



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## Table of Contents

# An Ultra Low Power Cryo-Refrigerator for Space, Phase II

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| Organizations Performing Work | Role | Type | Location |
|---|---|---|---|
| Creare LLC | Lead Organization | Industry | Hanover, New Hampshire |
| Goddard Space Flight Center(GSFC) | Supporting Organization | NASA Center | Greenbelt, Maryland |

| Primary U.S. Work Locations | |
|---|---|
| Maryland | New Hampshire |

## Project Transitions

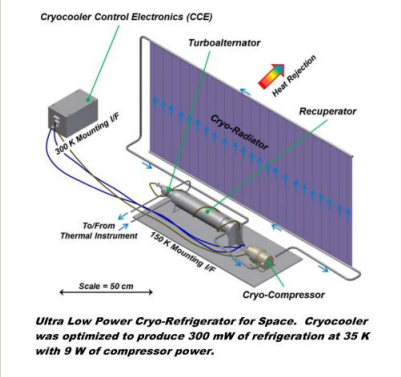
**April 2012:** Project Start

**June 2014:** Closed out

**Closeout Documentation:**

- Final Summary Chart*(https://techport.nasa.gov/file/137926)*

## Images




**Project Image**
An Ultra Low Power Cryo-Refrigerator for Space
*(https://techport.nasa.gov/image/136216)*

## Organizational Responsibility

**Responsible Mission Directorate:**
Space Technology Mission Directorate (STMD)

**Lead Organization:**
Creare LLC

**Responsible Program:**
Small Business Innovation Research/Small Business Tech Transfer

## Project Management

**Program Director:**
Jason L Kessler

**Program Manager:**
Carlos Torrez

**Principal Investigator:**
Mark Zagarola

**Co-Investigator:**
Mark Zagarola

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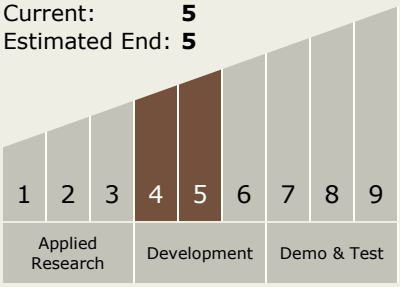
## Technology Maturity (TRL)

Start: **4**
Current: **5**
Estimated End: **5**




## Technology Areas

**Primary:**

- TX14 Thermal Management Systems
  - TX14.1 Cryogenic Systems
    - TX14.1.3 Thermal Conditioning for Sensors, Instruments, and High Efficiency Electric Motors

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System